Appendix E: Water Consumption Report

The Marine Mammal Center
Summary of Anticipated Water use
Relative to Historic Norms

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Contents

Part 1 *Introduction and Purposes of this Summary*

The purpose of this report is to summarize the projected annual water use for The Marine Mammal Center (TMMC) at Fort Cronkhite, Marin Headlands as represented by the Schematic Design and as compared to historic use.

As a non-profit organization reliant upon philanthropy and donations, TMMC has been very resourceful in acquiring the resources, materials and systems necessary for the care of more than 600 animals per year. Over time, systems have been incrementally expanded in the most economically feasible and expeditious manner available. The gradual expansion of the infrastructure was accomplished without the benefit of a master plan defining the goals and guiding the implementation of system revisions.

The majority of water used by TMMC programs is directly related to animal care; more specifically, the majority of water is utilized in the Life Support Systems (LSS) that clean and re-circulate water contained in the animal kennel pools. Domestic water utilization makes up the balance of total water use. As defined for this report, domestic water use includes washing the animal kennels. The current LSS systems have evolved into inefficient and often unreliable systems that deliver marginal water quality under certain environmental conditions.

The modernized LSS systems represented in the Schematic Design are based on a comprehensive analysis by TMMC and the design team defining the goals for animal care. Project goals and systems have been validated against comparable animal care institutions including the Bodega Marine Lab (UC Davis), Marine World, the Monterey Bay Aquarium, Long Marine Lab at Santa Cruz and consideration of TMMC historic records.

In preparing this report, the design team has researched current operations or conditions at TMMC and adopted fundamental assumptions that guide the design intent. These assumptions include:

- ✓ *That the total water available to all facilities in the Headlands is limited by the capacity of a single municipal supply pipe line.*
- ✓ *That the comprehensive project approval would be contingent in part upon environmental assessments including water use.*
- ✓ *That TMMC would be allowed to consolidate the institutional programs, improve animal care to more diverse species and modernize the LSS systems provided the water consumption remained relatively consistent with historic use.*

The team expects this report will demonstrate that the re-designed systems represented by the Schematic Design will improve and expand the diversity of animal care while reducing water consumption relative to historic use under 98% of environmental conditions.

Part 2 *Existing Systems Description*

Water use for the existing facilities is estimated based on water meter readings from December 1997 through June 2002. This data was provided by TMMC and is shown in the table in Appendix B-7.

For the purpose of this evaluation, annual water uses for existing conditions are presented in two categories. The first category is based on animal loading conditions and would represent a 'typical year', while the second category is based on higher animal loading conditions that occur during El Nino events occurring at approximately 7-8 year intervals. According to TMMC's records, the most recent El Nino event occurred during 1998.

The current total volume of water contained in existing pools totals about 47,000 gallons assuming all pools are concurrently filled. The total volume capacity of the pools is not, however, the basis of annual water use. Based on the utilities record (Appendix B-7), the following volumes are historical averages for annual water use at TMMC:

Category One, Typical Condition: 4,520,000 gallons per year
Category Two, El Nino Condition: 5,950,000 gallons per year

The average water use for typical conditions is based on water meter readings from quarter one of 1999 through quarter two of 2002. The average water use for El Nino conditions is based on water meter readings from quarters one through four of 1998. These averages include water use for the LSS systems, wash down of the animal pens and other general plumbing demands at the facility. The estimated percentage of

existing water use for each of these demands is summarized below and in Appendix A Domestic Water Use Calculation.

Water use for the existing life support systems is assumed to include demands for backwashing the filters, flushing of the pools for water quality purposes, dumping and filling of pools for animal husbandry purposes, and intermittent maintenance work associated with the life support systems.

Backwashing the Water Filters is a fundamental operation necessary to purge the filters of accumulated particles so that the filters can continue to cleanse the re-circulated water. Backwashing the filters uses a lot of water and modern LSS systems are often designed to 'recover' water during the backwash cycle. 'Backwash recovery' capability for the existing LSS is limited at TMMC.

Domestic water use includes the animal care program for feeding the animals and washing down their kennel enclosures; domestic water use for people includes personal hygiene, comfort and meal preparation. The Domestic Water Use Calculation is provided in Appendix A. Our investigation shows that the single largest source of domestic water use is in washing down the existing pen enclosures. On-site testing confirmed that the hose connections used in washing down the pens deliver 15 Gallons per Minute (GPM) of water. Each of the 28 existing kennels is 'washed down' for 10 minutes 3 times per day (when occupied). Pens are typically occupied by animals 4 months (30 days x 4 = 112 days) of the year. A quick calculation determines that the wash-down function is responsible for about 1.3 million Gallons Per Year (15 GPM x 10 Minutes x 3 wash-downs x 28 kennels x 30 days x 4 months = 1,512,000 gallons).

In their current configuration; the LSS systems Filters, Basins, Piping etc… at TMMC are all above-grade and are exposed to sunlight resulting in UV degradation of equipment (a-long-term maintenance issue) and, more importantly, heat-gain is introduced into the water circulating through the systems. An unfortunate dynamic exists whereas the heat-gain introduced to the water systems typically coincides during the months of highest animal populations. Bacteria flourish in warmer water therefore this operational coincidence results in the out-dated LSS systems under-performing and delivering the poorest water quality just when the systems and staff are the most stressed. The poorer water quality during this time is not only an added health risk to the animals but results in conditions that are not safe for the staff working with the animals in the pools.

Part 3 *Proposed Systems Performance*

The volume of water in pools represented by the Schematic Design totals about 207,000 gallons assuming all pools are concurrently filled. This represents an increase of 160,000 gallons over the 47,000 gallons current capacity. However; as we have demonstrated in the Existing Systems Summary the total volume capacity of the pools is not in itself the basis of annual water use.

Similar to existing water uses, future water use for the life support systems is assumed to include demands for backwashing the filters and flushing of the pools for water quality purposes. Because a pump-down basin for reserve water storage is designed into the new facility, it is assumed that dumping water directly to sewer and filling of the pools with fresh water directly from the water district for animal husbandry purposes will be minimal. The basin will allow water to be metered back to the sewer system in a predictable designed manner.

The estimated water use for each of these LSS demands is based on the new pool volumes and the anticipated animal and food loads provided by TMMC. These animal and food loads are summarized in Appendix B2-B4. These tables show that the average monthly animal loads (based on an annual average) are 50 animals during 'normal' conditions and 96 animals during El Nino conditions. The anticipated peak month animal loads are 72 animals during 'normal' conditions and 230 animals during El Nino conditions.

Water use is dependent upon operational practices; therefore a range of estimated water use was developed for the modernized life support systems. The highest estimated water uses are based on conservative operational assumptions; while the lowest estimated water uses are based on typical or average operating assumptions. The estimated water uses for both cases are shown in Tables 1.1 through 1.5 and Tables 2.1 through 2.5, respectively.

As shown in these tables, the water uses were estimated for each set of assumptions based on animal and food loads for typical and El Nino conditions. For the purposes of this evaluation, the conservative operating assumptions are based on an average backwash duration of six minutes and maximum filter loading of 0.4 lbs of solids per square foot of filter area; while the typical or average operating assumptions are based on an average backwash duration of five minutes and a maximum filter loading of 0.5 lbs of solids per square foot of filter area. All other operating assumptions were considered equal for both cases.

A backwash recovery system has been incorporated into the proposed design to conserve and minimize water use. Currently, backwash recovery capability is limited and some water is 'wasted' in the backwash process. The backwash recovery system will allow the water used during the backwash cycle to be recovered and reused rather than discharged to sewer. Because the backwash recovery filters can be more heavily

loaded than the main filters, the backwash recovery systems will significantly reduce the volume of water required to backwash the filters.

Comparing total water use in the LSS systems with and without a backwash recovery system; incorporating backwash recovery systems is expected to reduce the overall water use in the proposed design by approximately 60 percent (compare Appendices B3 and B4). This reduction is estimated to be approximately 3.5 million gallons per year and 6.8 million gallons per year for typical and El Nino conditions, respectively. The estimated water uses for backwashing the main filters without backwash recovery systems are shown in Tables 3.1 through 3.3 in Appendix B4.

Currently, the existing pools are dumped and filled approximately once per week during peak loading conditions to help maintain acceptable water quality. To maintain the same flushing rate for future conditions based on animal load per unit volume, the dump and fill rate is expected to change to approximately once every two and a half weeks for future conditions. It is assumed that this dump and fill rate will be used for all new animal holding pools, with the exception of the cetacean pools. Because the animal loads in the cetacean pools is expected to be very low compared to the animal loads in other pools, the design assumes that the new cetacean pools will be flushed at a rate of approximately ten percent per month over the course of the year. The estimated water volumes for flushing the new pools is 1,438,771 gallons as summarized in Table 4.1 Appendix B-5.

The estimated water volume for the modernized Life Support System (LSS) represented by the Schematic Design are summarized in Tables 1 and 2 of Appendix B-6. As shown in these tables, water uses are expected to range from 45 to 87 percent of the total existing water use during typical conditions and from 52 and 99 percent of the total existing water use during El Nino conditions. As mentioned above, these ranges have been developed to help illustrate the potential impact of operational practices on overall water use.

The domestic water use represented by the Schematic Design and summarized in Appendix A has been consolidated and reduced by incorporating low-flow domestic fixtures and by a strategy of reducing water use in the wash-down function at the animal pens. The design team proposes to reduce the water used in the wash-down operation by increasing the water pressure and limiting flow. By increasing the pressure to 1000 psi, slightly less than the water pressure at common coin-operated car wash facilities, with a flow of about 7.5 GPM would represent about a 25% reduction in the total water use compared with current practices.

The 25% reduction is derived by starting with the 1.512 million gallons of current use at 15 GPM (as validated in TMMC field testing) and adding a conservative 50% increase in surface area due to the new pen/pool design we would expect water use for the wash-down to equal 1.512 x 15 = 2.268 million gallons annual (a 756,000 gallon INCREASE)

By adopting a high-pressure washing strategy with 700-1000 psi water pressure at 7.5 GPM of flow we can reduce the expected flow by 50%. Multiplying the total demand at 2,268,000 gallons by 1/2 reduced flow equals a total anticipated demand of 1,134,000 gallons: a net reduction of 378,000 gallons annually compared to current practice. People oriented functions account for the remainder of domestic water use estimated at a total 1,223,232 gallons/year (see Appendix A).

Proposed Systems Basis of Design including backwash recovery:

Category One, Typical Environmental Conditions

The LSS systems represented in the Schematic Design will use approximately 2,476,000 gallons per year (table 1.4 Appendix B-2). Adding the estimated 1.225 million gallons per year for domestic use (Appendix A) equals 3,701,000 total gallons compared to 4,519,020 average annual benchmark (TMMC use during 1999-2002). The revised total water use represented by the Schematic Design is 82% of the current annual use under normal operating conditions.

Category Two, El Nino Environmental Condition:

The LSS systems represented in the Schematic Design will use approximately 4,775,799 gallons per year (Table 1.5 Appendix B-2): adding the estimated 1.225 million gallons per year for domestic use (Appendix A) equals 6,000,799 total gallons of total water use. Comparing the 5,949,167 gallons annual benchmark (TMMC water use during 1998 El Nino year shown on Appendix B7) the total water use represented by the Schematic Design is 101% of current use.

The totals represented in the tables should be understood to represent a range of water utilization with best-practice operational assumptions. Considering the precision inherent in the assumptions used to calculate these quantities, we conclude that water use will remain un-changed during El Nino conditions. Although the water use during extraordinary El Nino conditions (occurring every 7-8 years) remains within historic use; water use should be monitored to avoid exceeding budgeted amounts during extreme environmental conditions of the immediate micro-climate at the project site.

***Part 4** Conclusions*

The Schematic Design represents fully modernized Life Support Systems supporting the animal holding pens and pools. Although the Schematic Design increases the total water capacity in the holding pools from 47,000 gallons to 207,000 gallons, instantaneous demands remain unchanged and the annual use decreases to 82% of historic water use when compared to an average year. The design reduces water consumption in all but the most extreme El Nino conditions and only when those conditions coincide with very warm environmental conditions.

Further, the Schematic Design expands the diversity of animal care while conserving water and energy use by:

- ✓ *Incorporating backwash recovery systems into the LSS system*
- ✓ *Increasing water pressure for wash down functions (reducing volume)*
- ✓ *Hard shading at the pens replaces current spray misting (evaporative cooling)*
- ✓ *closed vessels reduce the percentage of evaporative water loss*
- ✓ *re-using water through backwash recovery that is otherwise wasted*
- ✓ *more dependable water quality reduces 'water dumping' operations*
- ✓ *Water metering and storage basins improve operational flexibility*
- ✓ *Automated electronic controls improve predictability & control of operations*
- ✓ *Specifying restricted-flow devices on domestic fixtures*
- ✓ *Minimizing fluctuations in water temperature by shading rather than by mechanical means (chilling).*

The comprehensive design reduces water consumption in all but the most extreme El Nino conditions when animal populations are at the maximum and the site micro-climate is experiencing seasonably warm conditions. To say this more simply, hot days + maximum animals = more water processing to keep the water healthy.

Animal populations during extraordinary El Nino conditions might coincide with seasonably warm environmental conditions for as long as a month during an El Nino event every 7- 8 years. This expectation correlates to 1 month out of every 84 months where water use represented by the Schematic Design might match or slightly exceed historic water use during an El Nino year.

Stated another way, the Schematic Design improvements with adjustments to the operational culture will result in using less water than TMMC has used historically in at least 98% of all environmental conditions at the project site. Calculating total water use during a seven year period where water use is reduced by 18% for 6 of seven years and matched during the El Nino year; the modernized systems in the Schematic Design could result in reducing annual water use by an average of more than 500,000 gallons per year.

End of Report

Part 5 Appendices

A. *Domestic Water Engineering Data/Calculation*
B. *LSS Water Engineering Data*
C. *Acknowledgements*

Appendix A: Domestic Water Data/Calculations for the proposed design

Assumptions for calculations

- ✓ *Staff - 40 people x 8 hours/day Monday thru Friday*
- ✓ *Volunteers - 12 people x 24 hours/day 7 days/week*
- ✓ *Visitors – 100,000 per year for 1 hour, 12 GP day /8 hour*
- ✓ *Hose Bibbs - 30 Pens x 7.5 GPM/HB x 10 minutes per wash down - 3 wash down per day (½ pens occupied / year)*
- ✓ *Fish Prep Kitchen - water used for food preparation for each animal would be 1/2 gallon/feeding (to thaw or rinse food) 4 feedings/day 600 animal year averaging a 28 day stay*

Average Daily Water Use Calculation/Person

Men Toilet Room Use

3 times at urinal = 3 gallons
1 time at water closet = 1.6 gallons
4 times at lavatory for 30 seconds at 2.5 GPM = 5 gallons
Total = 9.6 gallons

Women Toilet Room Use

4 times at water closet = 6.4
4 times at lavatory for 30 seconds at 2.5 GPM=5 gallons
Total= 11.4 gallons

Average of men & women = 10.5
Allow another 1.5 gallons/person for dishwasher /coffee making/janitor sink.
Total 12 gallons a day / person.

Continued…

Calculation of Water Use by Function

- ✓ *Staff 40 people on x 12 GPD x 5 days/week x 52 week = 124,800 GPYear*
- ✓ *Volunteers 12 people x 24 GPD x 7 days/week x 52 week = 104,832 GPYear*
- ✓ *Visitors 100,000 people/year x 1 hour / visit x 12 Gallons Per Day / 8hours / day = 150,000 Gallons Per Year*
- ✓ *High-Pressure Hose Bibbs for holding pen wash-down (pens occupied 4 months of year) 30 Pens x 7.5 GPM x 10 minutes / wash down x 3 wash down/day x 4 months (30x4) = 810,000 Gallons Per Year*
- ✓ *Fish Prep Kitchen - water used for food prep for each animal 1/2 gallons/feeding (to thaw or rinse food) 4 feedings/day 600 animal year averaging a 30 day stay = 1/2gal x 4 meals x 600 animals x 30 days = 36,000 Gallons Per Year*

Total Domestic Water Use Estimate
124800+104832+150,000+810,000+36000 = budget ***1,225,000 Gallons Per Year***

Appendix A continued

The Marine Mammal Center
Estimated Water Use for Future Life Support Systems
Prepared by PBS&J
January 9, 2002

CASE 1: CONSERVATIVE OPERATING ASSUMPTIONS

Table 1.1 - Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

System	No. of Animals	Average Weight of One Animal (lb)	Food Load (% of body weight/d)	Feed Rate (lb/d)	Percent Solids in Food by Weight (%)	Percent of Food Load to Filters (%)	Solids Load to Filters (lb/d)	Max Filter Load (lb/sf)	Area of Filter Required for One BW/Day (sf)	Main Filter Size	Area of One Main Filter (sf)	Qty of Main Filters	Total Area of Main Filters (sf)
General Pinniped Pools	33	200	5%	330	15%	85%	42	0.4	105	4' D x 8' L	32	4	128
Cetacean Pools	1	500	5%	25	15%	85%	3	0.4	8	3.5' D x 4' L	14	3	42
G Pools	28	200	5%	280	15%	85%	36	0.4	89	4' D x 6' L	24	4	96
Hospital	10	50	10%	50	15%	85%	6	0.4	16	36" D	7.06	4	28

Table 1.2 - Freshwater BWR Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

Max Solids Load to BWR Filters (lb/d)	Max BWR Filter Load (lb/sf)	BWR Filter Size	Qty of BWR Filters	Area of BWR Filters (sf)	Max Load Per Filter (lbs)	No. of BW per Day	BW Flow Rate (gpm)	BW Duration (min)	Volume per BW (gal)	BW Volume per day (gal)	BW Volume per Month (gal)
35	0.8	60" Dia.	1	20	16	2.2	353	6	2,120	4,668	141,979

Table 1.3 - Saltwater BWR Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

Max Solids Load to BWR Filters (lb/d)	Max BWR Filter Load (lb/sf)	BWR Filter Size	Qty of BWR Filters	Area of BWR Filters (sf)	Max Load Per Filter (lbs)	No. of BW per Day	BW Flow Rate (gpm)	BW Duration (min)	Volume per BW (gal)	BW Volume per day (gal)	BW Volume per Month (gal)
37	0.8	60" Dia.	1	20	16	2.4	353	6	2,120	5,048	153,543

Table 1.4 - Total LSS Water Demand for Backwashing BWR Filters and Flushing Tanks for Typical Conditions (Non El Nino)

Volume of Potable Water Req'd to BW All Filters for Peak Month (gal/month)	Annual Average Food Load as Percent of Maximum Month	Total Volume of Potable Water to BW All Filters (gal/year)	Existing Potable Water Use per Year for Typical Conditions 1999 - 2002 (gal)	Estimated Future LSS Water Use as Percentage of Existing Water Use
295,521	70%	2,476,340	4,519,020	54.8%

Table 1.5 - Total LSS Water Demand for Backwashing BWR Filters and Flushing Tanks for El Nino Conditions

Volume of Potable Water Req'd to BW All Filters for Peak Month (gal/month)	Annual Average Food Load as Percent of Maximum Month	Ratio of Food Loads for El Nino and Typical Conditions for Peak Month (May)	Total Volume of Potable Water to BW All Filters (gal/year)	Existing Potable Water Use per Year for 1998 El Nino Conditions (gal)	Estimated Future LSS Water Use as Percentage of Existing Water Use
295,521	42%	3.20	4,775,799	6,266,500	76.2%

Appendix B-2
(Appendix B-1 not used)

The Marine Mammal Center
Estimated Water Use for Future Life Support Systems
Prepared by PBS&J
January 9, 2002

CASE 2: TYPICAL OPERATING ASSUMPTIONS

Table 2.1 - Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

System	No. of Animals	Average Weight of One Animal (lb)	Food Load (% of body weight/d)	Feed Rate (lb/d)	Percent Solids in Food by Weight (%)	Percent of Food Load to Filters (%)	Solids Load to Filters (lb/d)	Max Filter Load (lb/sf)	Area of Filter Required for One BW/Day (sf)	Main Filter Size	Area of One Main Filter (sf)	Qty of Main Filters	Total Area of Main Filters (sf)
General Pinniped Pools	33	200	5%	330	15%	85%	42	0.5	84	4' D x 8' L	32	4	128
Cetacean Pools	1	500	5%	25	15%	85%	3	0.5	6	3.5' D x 4' L	14	3	42
G Pools	28	200	5%	280	15%	85%	36	0.5	71	4' D x 6' L	24	4	96
Hospital	10	50	10%	50	15%	85%	6	0.5	13	36" D	7.06	4	28

Table 2.2 - Freshwater BWR Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

Max Solids Load to BWR Filters (lb/d)	Max BWR Filter Load (lb/sf)	BWR Filter Size	Qty of BWR Filters	Area of BWR Filters (sf)	Max Load Per Filter (lbs)	No. of BW per Day	BW Flow Rate (gpm)	BW Duration (min)	Volume per BW (gal)	BW Volume per day (gal)	BW Volume per Month (gal)
28	1.0	60" Dia.	1	20	20	1.4	353	5	1,766	2,489	75,722

Table 2.3 - Saltwater BWR Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

Max Solids Load to BWR Filters (lb/d)	Max BWR Filter Load (lb/sf)	BWR Filter Size	Qty of BWR Filters	Area of BWR Filters (sf)	Max Load Per Filter (lbs)	No. of BW per Day	BW Flow Rate (gpm)	BW Duration (min)	Volume per BW (gal)	BW Volume per day (gal)	BW Volume per Month (gal)
30	1.0	60" Dia.	1	20	20	1.5	353	5	1,766	2,692	81,889

Table 2.4 - Total LSS Water Demand for Backwashing BWR Filters and Flushing Tanks for Typical Conditions (Non El Nino)

Volume of Potable Water Req'd to BW All Filters for Peak Month for Typical Conditions (gal/month)	Volume of Potable Water Req'd to BW All Filters for Peak Month for Typical Conditions (gal/month)	Total Volume of Potable Water to BW All Filters (gal/year)	Existing Potable Water Use per Year for Typical Conditions 1999 - 2002 (gal)	Estimated Future LSS Water Use as Percentage of Existing Water Use
157,611	70%	1,320,715	4,519,020	29.2%

Table 2.5 - Total LSS Water Demand for Backwashing BWR Filters and Flushing Tanks for El Nino Conditions

Volume of Potable Water Req'd to BW All Filters for Peak Month for Typical Conditions (gal/month)	Annual Average Food Load as Percent of Maximum Month	Ratio of Food Loads for El Nino and Typical Conditions for Peak Month (May)	Total Volume of Potable Water to BW All Filters (gal/year)	Existing Potable Water Use per Year for 1998 El Nino Conditions (gal)	Estimated Future LSS Water Use as Percentage of Existing Water Use
157,611	42%	3.20	2,547,093	6,266,500	40.6%

Appendix B-3

The Marine Mammal Center
Estimated Water Use for Future Life Support Systems
Prepared by PBS&J
January 9, 2002

CASE 3: COMPARISON OF WATER USE ASSUMING NO BACKWASH RECOVERY SYSTEMS

Table 3.1 - Filter Backwash Summary Based on Animal and Food Loads for Peak Month during Typical Conditions (Non El Nino)

System	No. of Animals	Average Weight of One Animal (lb)	Food Load (% of body weight/d)	Feed Rate (lb/d)	Percent Solids in Food by Weight (%)	Percent of Food Load to Filters (%)	Solids Load to Filters (lb/d)	Max Filter Load (lb/sf)	Area of Filter Required for One BW/Day (sf)	Main Filter Size	Area of One Main Filter (sf)	Qty of Main Filters	Total Area of Main Filters (sf)
General Pinniped Pools	33	200	5%	330	15%	85%	42	0.4	105	4' D x 8' L	32	4	128
Cetacean Pools	1	500	5%	25	15%	85%	3	0.4	8	3.5' D x 4' L	14	3	42
G Pools	28	200	5%	280	15%	85%	36	0.4	89	4' D x 6' L	24	4	96
Hospital	10	50	10%	50	15%	85%	6	0.4	16	36" D	7.06	4	28

Table 3.2 - LSS Water Use for Peak Month during Typical Conditions (Non El Nino) - Assuming No Backwash Recovery System

System	BW Flow Rate (gpm)	BW Duration (min)	Volume of BW Water during Peak Month (gallons)	Annual Average Food Load as Percent of Maximum Month	Total Volume of Potable Water to BW All Filters (gal/year)
General Pinniped Pools	576	6.0	345,541	70%	2,902,544
Cetacean Pools	252	6.0	26,177	70%	219,890
G Pools	432	6.0	293,186	70%	2,462,765
Hospital	127	6.0	52,392	70%	440,091
					6,025,289

Table 3.3 - LSS Water Use for Peak Month during Typical Conditions (Non El Nino) - Assuming No Backwash Recovery System

System	BW Flow Rate (gpm)	BW Duration (min)	Ratio of Food Loads for El Nino and Typical Conditions for Peak Month (May)	Volume of BW Water during Peak Month (gallons)	Annual Average Food Load as Percent of Maximum Month	Total Volume of Potable Water to BW All Filters (gal/year)
General Pinniped Pools	576	6.0	3.20	1,104,722	42%	5,567,799
Cetacean Pools	252	6.0	3.20	83,691	42%	421,803
G Pools	432	6.0	3.20	937,340	42%	4,724,194
Hospital	127	6.0	3.20	167,501	42%	844,203
						11,557,999

Appendix B-4

The Marine Mammal Center
Estimated Water Use for Future Life Support Systems
Prepared by PBS&J
January 9, 2002

CASE 4: ESTIMATE VOLUME OF WATER REQUIRED TO FLUSH POOLS

Table 4.1 - Volume Required to Flush Pools for Peak Month during Typical Conditions

System	Volume of Pools (gallons)	Percent Flushing per Month during Peak Month*	Volume Required for Flushing during Peak Month (gallons)	Annual Average Food Load as Percent of Maximum Month	Annual Average Volume Required for Flushing Pools (gallons)
General Pinniped Pools	47,000	150%	70,500	70%	590,759
Cetacean Pools	106,000	10%	10,600	70%	88,823
G Pools	54,000	150%	81,000	70%	678,745
Hospital	6,400	150%	9,600	70%	80,444
					1,438,771

*Percent flushing per month based on existing approach of dumping each pool once per week during peak conditions. Factoring this amount of flushing by the increase in water volume for the new facility requires approximately 150 percent flushing each month for the pinniped pools.

The Marine Mammal Center
Preliminary Comparison of Existing and Future LSS Water Consumption
Prepared by PC Aquatics, a PBS&J Program
January 2003

Table 1 - Summary of Water Use for Typical (Non El Nino) Conditions

Name of Life Support System	Estimated Water Consumption for Filter Backwash (gallons)		Estimated Water Consumption for Tank Flushing (gallons)		Total Estimated Water Consumption (gallons)	
	Low	High	Low	High	Low	High
1. General Pinniped Pools	N/A	N/A	295,380	590,759	295,380	590,759
2. Cetacean Pools	N/A	N/A	44,412	88,823	44,412	88,823
3. G Pools	N/A	N/A	339,372	678,745	339,372	678,745
4. Hospital Pools	N/A	N/A	40,222	80,444	40,222	80,444
5. Backwash Recovery Systems	1,320,715	2,476,340	N/A	N/A	1,320,715	2,476,340
Total Future Estimated Water Consumption	**1,320,715**	**2,476,340**	**719,385**	**1,438,771**	**2,040,100**	**3,915,111**
Total Existing Water Use Consumption					**4,519,020**	**4,519,020**
Future LSS Water Use as Percentage of Existing Water Use					**45%**	**87%**

Table 2 - Summary of Water Use for El Nino Conditions

Name of Life Support System	Estimated Water Consumption for Filter Backwash (gallons)		Estimated Water Consumption for Tank Flushing (gallons)		Total Estimated Water Consumption (gallons)	
	Low	High	Low	High	Low	High
1. General Pinniped Pools	N/A	N/A	295,380	590,759	295,380	590,759
2. Cetacean Pools	N/A	N/A	44,412	88,823	44,412	88,823
3. G Pools	N/A	N/A	339,372	678,745	339,372	678,745
4. Hospital Pools	N/A	N/A	40,222	80,444	40,222	80,444
5. Backwash Recovery Systems	2,547,093	4,775,799	N/A	N/A	2,547,093	4,775,799
Total Future Estimated Water Consumption	**2,547,093**	**4,775,799**	**719,385**	**1,438,771**	**3,266,478**	**6,214,569**
Total Water Consumption for Existing LSS					**6,266,500**	**6,266,500**
Future LSS Water Use as Percentage of Existing Water Use					**52%**	**99%**

Appendix B-6

The Marine Mammal Center
Water Use Data for 1998 through 2002
Data Provided by The Marine Mammal Center

Water Utilities Records					Program Cost					
Year	QTR	Service Period	Amount Paid	Total Pd/Yr	Program Water (KGAL)	Program Sewer (KGAL)	Rate per KGAL of Water ($)	Rate per KGAL of Sewer ($)	Total Program Cost	Total Program Water (KGAL)
1998	1	12/5/97 - 3/9/98	$7,616		952.0	952.0			$0	
	2	3/9/98 - 6/5/98	$15,538		1,942.2	1,942.2			$0	
	3	6/5/98 - 9/10/98	$17,576		2,197.0	2,197.0			$0	
	4	9/10/98 - 1/7/99	$9,402		1,175.3	1,175.3			$0	
				50,132						**6,266.5**
1999 *	1 to 2	1/7/99 - 5/10/99	$7,700		962.5	962.5			$0	
	2 to 3	5/10-9/10/99	$12,310		1,774.1	1,774.1			$0	
	4	9/10/99 - 12/11/99	$11,160		1,078.2	1,078.2	6.939	2.552	$10,233	
				31,171						**3,814.8**
2000	1	12/11/99 - 3/13/00	$9,692		1,016.5	1,016.5	6.939	2.552	$9,648	
	2	3/13/00 - 6/9/00	$10,597		1,030.5	1,030.5	6.939	2.552	$9,780	
	3	6/9/00 - 9/8/00	$25,094		2,528.8	2,528.8	6.939	2.552	$24,001	
	4	9/8/00 - 12/4/00	$18,113		1,715.5	1,715.5	7.48	2.858	$17,735	
				63,495						**6,291.3**
2001	1	12/4/00 - 3/8/01	$5,575		466.7	466.7	7.48	2.858	$4,825	
	2	3/8/01 - 6/5/01	$17,465		1,515.5	1,515.5	7.48	2.858	$15,667	
	3	6/5/01 - 9/10/01	$12,140		1,053.3	1,053.3	7.48	2.858	$10,889	
	4	9/10/01 - 12/7/01	$5,473		601.6	601.6	6.053	1.378	$4,470	
				40,653						**3,637.1**
2002	1	12/7/01 - 3/4/02	$4,870		460.5	460.5	6.822	1.966	$4,047	
	2	3/4/02 - 6/7/02	$9,230		960.2	960.2	6.906	1.861	$8,418	
	3									
	4									
				14,100						**1,420.7**

Summary and Averages :
6,266,500 Avearge gallons per year during El Nino Conditions Based on Q1 thru Q4 1998
4,519,018 Avearge gallons per year during typical (non El Nino) Conditions Based on Q4 1999 thru Q2 2002

*** Not including 1999 Q's 1-3 due to service period dates being off**

Note: to establish Benchmark El-Nino year reduce 'Total Program Water' for 1998 by 1/3 of water used in the first quarter to avoid double-counting the month of December.
1/3 x 952,000 Gallons = 317,333 gallons.
Total 6,266,500 less 317,333 gallons = ***5,949,167 gallons El Nino Benchmark Year***

Appendix B-7

The Marine Mammal Center
Monthly Animal and Food Loading by System
Data Provided by Richard Brown at TMMC
January 2003

Table 1. Average Monthly Animal and Food Loads for Typical Conditions

	January		February		March		April		May		June		July		August		September		October		November		December	
System	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)
General Pinniped Pools	0	0	29	290	37	370	29	290	33	330	19	190	2	20	23	230	28	280	35	350	0	0	0	0
Cetacean Pools	0	0	0	0	1	25	1	25	1	25	1	25	1	25	1	25	1	25	1	25	1	25	0	0
"G" Pools	24	240	15	150	15	150	10	100	28	280	32	320	32	320	32	320	32	320	32	320	30	300	14	140
Hospital Pools*	0	0	3	15	6	30	6	30	10	50	6	30	7	35	3	15	0	0	0	0	0	0	0	0
Totals	24	240	47	455	59	575	46	445	72	685	58	565	42	400	59	590	61	625	68	695	31	325	14	140
Percent of Maximum	33%	35%	65%	66%	82%	84%	64%	65%	100%	100%	81%	82%	58%	58%	82%	86%	85%	91%	94%	101%	43%	47%	19%	20%

Annual Average Food Load as Percent of Maximum = 70%

Table 2. Average Monthly Animal and Food Loads for El Nino Conditions

	January		February		March		April		May		June		July		August		September		October		November		December	
System	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)
General Pinniped Pools	27	270	47	470	69	690	71	710	168	1,680	118	1,180	52	520	46	460	26	260	40	400	0	0	0	0
Cetacean Pools	0	0	1	25	1	25	2	50	2	50	2	50	1	25	1	25	1	25	1	25	1	25	0	0
"G" Pools	32	320	32	320	32	320	32	320	32	320	32	320	32	320	32	320	32	320	32	320	30	300	15	150
Hospital Pools*	4	20	6	30	8	40	13	65	28	140	20	100	8	40	4	20	0	0	0	0	0	0	0	0
Totals	63	610	86	845	110	1,075	118	1,145	230	2,190	172	1,650	93	905	83	825	59	605	73	745	31	325	15	150
Percent of Maximum	27%	28%	37%	39%	48%	49%	51%	52%	100%	100%	75%	75%	40%	41%	36%	38%	26%	28%	32%	34%	13%	15%	7%	7%

Annual Average Food Load as Percent of Maximum = 42%

Ratio of Food Loads for El Nino and Typical Conditions = 1.93

* Hospital pools are based on 10% of the seal's body weight per day. All other pools are based on 5% of animal's body weight per day.

Table 3. Actual Monthly Animal and Food Loads for 1998 El Nino

	January		February		March		April		May		June		July		August		September		October		November		December	
System	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)	Average No. of Animals	Average Food Load (lb/day)
All Systems	70	700	82	820	110	1,100	132	1,320	274	2,740	198	1,980	99	990	68	680	31	310	42	420	11	110	7	70